Health Care Utilization in Persons with Traumatic Spinal Cord Injury: The Importance of Multimorbidity and the Impact on Patient Outcomes

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Background: Persons with spinal cord injury (SCI) living in the community have high health care utilization (HCU). To date, the interrelationships among multiple secondary health conditions (multimorbidity due to comorbidities and complications) that drive HCU and their impact on patient outcomes are unknown. **Objective:** To determine the association among multimorbidity, HCU, health status, and quality of life. **Methods:** Community-dwelling persons with traumatic SCI participated in an online/phone SCI Community Survey. Participants were grouped using the 7-item HCU questionnaire (group 1 did not receive needed care and/or rehospitalized; group 2 received needed care but rehospitalized; group 3 received needed care and not rehospitalized). Personal, injury, and environmental factors; multimorbidity (presence/absence of 30 comorbidities/ complications); health status (Short Form-12); and quality of life measures (Life Satisfaction-11 first question and single-item quality of life measure) were collected. Associations among these variables were assessed using multivariate analysis. **Results:** The 1,137 survey participants were divided into 3 groups: group 1 (n = 292), group 2 (n = 194), and group 3 (n = 650). Group 1 had the greatest number of secondary health conditions (15.14 ± 3.86) followed by group 2 (13.60 ± 4.00) and group 3 (12.00 ± 4.16) (P < .05). Multimorbidity and HCU were significant risk factors for having a lower SF-12 Mental (P < .001) and Physical Component Score (P < .001). They in turn were associated with participants reporting a lower quality of life (P < .001, for both questions). **Conclusions:** Multimorbidity and HCU are interrelated and associated with lower health status, which in turn is associated with lower quality of life. Future work will include the development of a screening tool to identify persons with SCI at risk of inappropriate HCU (eg, rehospitalization, not able to access care), which should lead to better patient outcomes and cost savings.
Key words: *access to care, secondary health conditions, health care utilization, health status, multimorbidity, rehospitalization, spinal cord injury*

Spinal cord injury (SCI) is a devastating injury that impairs motor, sensory, and autonomic function. These impairments result in profound disability and multiple secondary health conditions (SHCs; multimorbidity due to comorbidities/complications) that require ongoing management. The chronic nature of these conditions requires a shift from an acute medical model to a chronic health model, similar to that for diabetes or heart disease, whereby patients are empowered to manage their own health. However, as DeJong stated, "Persons with SCI have a specific constellation of ongoing health problems that are not being addressed by the mainstream of the American health care system, and that demand the attention of the health services research community."[1(p374)]

Persons with SCI frequently need to access the health care system. In Canada, it was reported that persons with SCI were 2.7 times more likely to contact physicians, were 2.6 times more likely to be rehospitalized, and required 30 times more hours of home care services compared to the general population.[2] Between 2003 and 2006, 27.5% of all persons discharged with a traumatic SCI living in Ontario were rehospitalized in their first year post injury.[3] There was also a high utilization of emergency services, with 17.5% of these visits

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being classified as preventable.[4] The reasons for seeking health care services include treatment for urinary tract infections, pneumonia, and other SHCs such as pressure ulcers and depression.[2,3] Multimorbidity associated with SCI makes it a very costly condition; it costs $21,450 annually to care for 1 person with chronic SCI in the United States.[5]

Previous work has identified predictors of high health care utilization (HCU). Hospital re-admissions have been associated with older age, living in a rural area, and a high utilization of physicians and specialists.[3] Use of emergency departments has been linked to living in a rural setting as well as low income and lower levels of physical functioning.[6,7] Results from these studies utilizing administrative data provide an overview of current HCU, but more work is needed to further understand how interrelationships among SHCs drive HCU and impact patient outcomes. For the field of rehabilitation research to advance, there is a need to address the complexities of having multiple SHCs, examine their interrelationships, and assess the impact on important outcomes such as health status, participation, and quality of life (QoL).[8]

To address these gaps, the objectives of this study were to (a) describe the HCU in the community for Canadians with traumatic SCI, (b) identify the factors associated with appropriate (received needed care and not rehospitalized) and inappropriate HCU (did not receive needed care and/or rehospitalized), and (c) describe the patient outcomes (health status, QoL) in persons with appropriate and inappropriate HCU using data gathered through SCI Community Survey (SCICS).

Methods

Survey overview

The SCICS was developed to assess major dimensions of community living and health outcomes in persons with SCI in Canada using an online and phone questionnaire. Details of the study methodology are described elsewhere.[9] To be included in the survey, individuals had to be at least 18 years of age, understand English or French, have sustained a traumatic or nontraumatic SCI, and have been living in the community for at least 1 year. For the purpose of this study, only persons with a traumatic mechanism of injury were included. HCU was assessed in the survey using a 7-item measure developed based on the Canadian Community Health Survey.[10] The measure asks the participants to report their HCU in the past 12 months by detailing the frequency of rehospitalization, number of health care professionals (HCPs) contacted, frequency of not being able to access needed care, reasons for not accessing needed care, and the type of needed care.

Factors Impacting HCU

Based on a recent scoping review,[11] Andersen's Behavioral Model of Health Care Utilization[12] was used as a conceptual model to identify factors that could influence HCU in this population. This model is commonly used in health services research to understand health and health outcomes.[12] Andersen's model was adapted and operationalized using the relevant variables from the survey (see **Figure 1**). Personal (eg, age, gender), injury (eg, type of SCI), and environmental factors (eg, living setting); needs (eg, attendant care needs); health behaviors (eg, participation in maintaining physical health); and SHCs (comorbidities/complications, eg, heart disease, presence of pressure ulcers, autonomic dysreflexia) were collected through the survey. Health status (assessed by the Short Form-12 [SF-12][13]) and QoL (measured using the 6-point-scale Life Satisfaction-11 [LiSAT-11] first question[14] and a 5-point-scale single-item measure, "How do you rate your overall quality of life? Think about the past two weeks, but don't focus on anything that may have happened [either a really good thing or a really bad thing] that is out of the ordinary.") were also collected through SCICS. The response options were collapsed into "not satisfied" / "poor" (response options 1-4 for LiSAT-11 first question and response options 1-3 for the single-item QoL measure) and "satisfied" / "good" (response options 5-6 for LiSAT-11 first question and response options 4-5 for the single-item QoL measure) for both questions.[14] The results comparing the frequency of responses

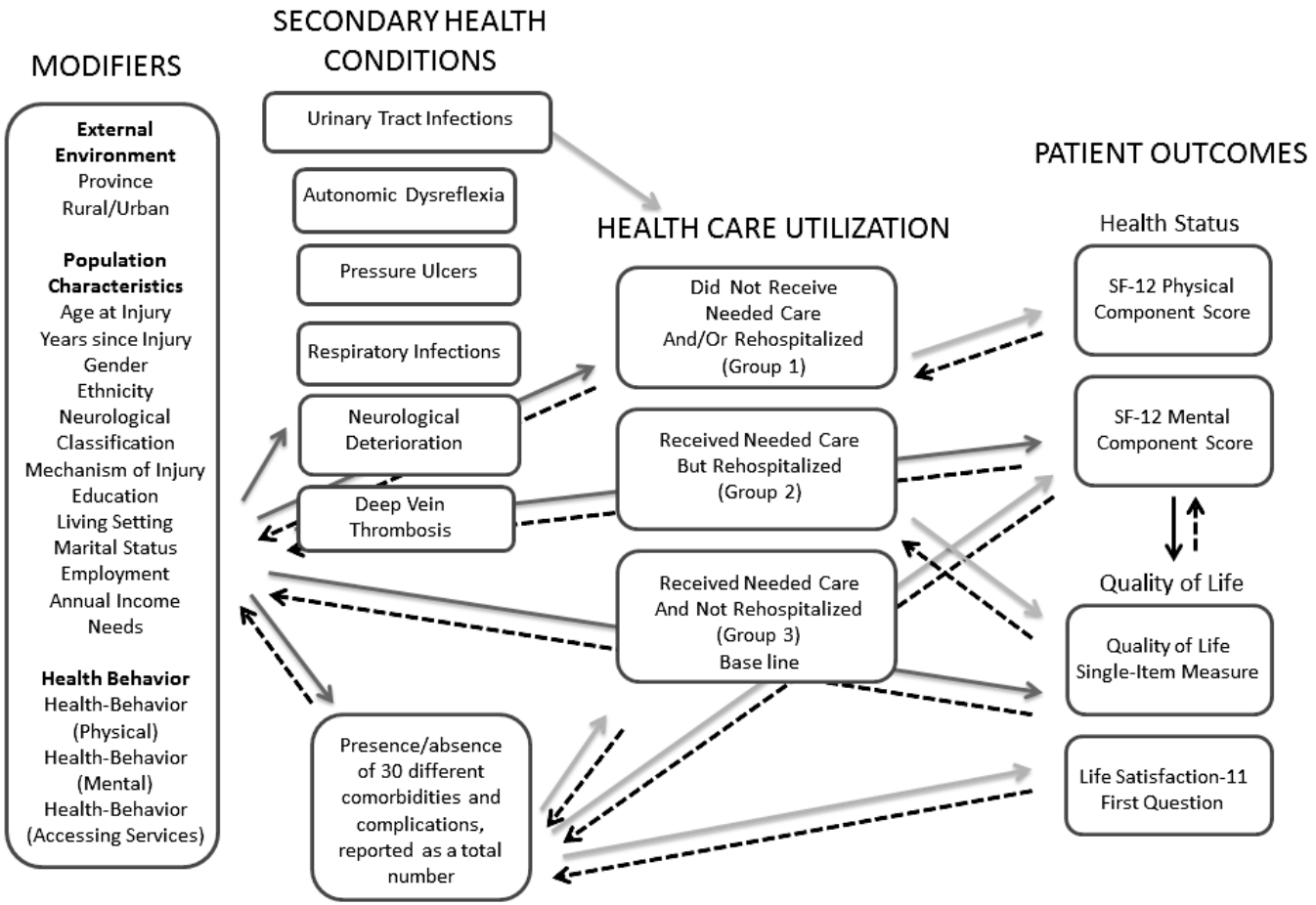

Figure 1. Applying Andersen's model to the SCI Community Survey data. Andersen's Behavioral Model of Health Care Utilization was the conceptual framework used to inform the analysis of the SCI Community Survey data. The solid arrows represent the results of the statistical analyses conducted and the dotted arrows represent the other hypothetical association that may exist but were not formally assessed in this article. For multimorbidity, 6 secondary health conditions (SHCs; urinary tract infections, autonomic dysreflexia, pressure ulcers, respiratory infections, neurological deterioration, deep vein thrombosis) were selected a priori as requiring health care services and compared with the total number of 30 SHCs (comorbidities/complications) reported by the participants. Using the total number of SHCs was superior to just using the 6 individual a priori SHCs, and these results were used to model the association with patient outcomes as described in the text.

between the 2 QoL measures are included in **Table A1** in **Appendix A**. A detailed list of all the variables considered in the analysis is included in **Table A2**.

Analyses

All analyses were conducted using IBM SPSS software version 21.0 (IBM Corp., Armonk, NY). A P value <.05 was considered statistically significant. After examining the results from the bivariate analyses using demographic, injury, and HCU variables, the participants were separated into 3 HCU groups defined by their responses to the HCU questions: group 1 did not receive needed care and/or rehospitalized, group 2 received needed care but rehospitalized, and group 3 received needed care and not rehospitalized. An analysis of variance (ANOVA) test followed by post hoc Duncan test was used to confirm that the groups were distinct from each other in terms of their multimorbidity (number of comorbidities/complications; SHCs). A second bivariate analysis was conducted to compare the 3 HCU groups for personal, injury, and environmental factors. Depending on the type of variable, the associations were examined using Wilcoxon-Mann-Whitney test, chi-square test, Fisher's exact test, or t test. Any factors that were statistically significant ($P <$ .05) or had a trend toward statistical significance ($P < .2$) were included in the multinomial logistic regression model.

Multinomial logistic regression models were developed to examine the effect of factors identified from the bivariate analyses on HCU and health outcomes. Two separate models were built to determine the effect of multimorbidity on HCU. In the first model, the covariates included the presence or absence of 6 SHCs (urinary tract infections, autonomic dysreflexia, pressure ulcers, respiratory infections, neurological deterioration, deep vein thrombosis) identified a priori as being most likely to result in rehospitalization. The second model included the total number of SHCs a participant reported out of 30 comorbidities/complications (coded as yes/no) as a covariate. This list was constructed from the Secondary Complications and Health Conditions (comorbidities) sections of the SCICS and similar SHCs were merged (eg, osteoporosis and bone fracture). The strength of the models was compared using Akaike Information Criterion (AIC), and the model that produced the best model fit (lower AIC value) were selected for the subsequent model that examined the association among HCU and health outcomes. A multiple linear regression model was used to assess effect of all factors on health status (Short Form-12 Physical [PCS] and Mental Component Scores [MCS]). Based on all the analyses, the binomial logistic regression model was built examining the effect of multimorbidity, HCU, and health status on QoL.

Results

A total of 1,137 participants living in the community with traumatic SCI were included in the analysis. See **Table 1** for the comprehensive demographic and injury information.

Description of HCU

Participants reported a high level of rehospitalization in the community; 26.1% (n = 297) of all participants reported being rehospitalized at least once in the past 12 months and the average length of stay among those who were rehospitalized was 23.5 days (SD 46.7). Frequency of seeing HCPs in an outpatient setting was also very high; 89.4% (n = 1,017) reported seeing at least 1 HCP in the past 12 months. Of those who saw an HCP at least once, the mean (SD) frequency of HCP contact was 32.7 times (62.0). The mean (SD) number of different types of HCPs seen was 3.5 (2.7) and the most commonly seen HCP type was general practitioners (79.5%; n = 904) followed by urologist (38.6%; n = 439). Despite high HCU observed in this population, the barriers to accessing needed care were also high: 25.7% (n = 292) of participants reported not being able to receive needed care at least once in the past 12 months. Of those who experienced this barrier, the mean (SD) frequency it occurred was 9.8 times (35.7). The most common reasons for not being able to receive needed care were problems with availability ("waiting time too long," 47.6% [n = 139]; "care not available at the time," 34.6% [n = 101]), but personal reasons were also quite common ["felt it would be inadequate," 17.8% [n

= 52], "decided not to seek care," 14.0% [n = 41]). The most common care needed but not received was treatment of a physical problem (83.2% [n = 243]). See **Table 2** for more details.

Factors associated with inappropriate HCU

The composition of the 3 HCU groups was as follows: group 1 (did not receive needed care and/or rehospitalized; n = 292), group 2 (received needed care but rehospitalized; n = 194), and group 3 (received needed care and not rehospitalized; n = 650). Group 1 had the greatest number of SHCs (15.14 ± 3.86) followed by group 2 (13.60 ± 4.00) and group 3 (12.00 ± 4.16) ($P < .05$). When the environmental, demographic, injury factors, and multimorbidity data were included in the multinomial logistic regression model as covariates and the HCU group was the dependent variable (ie, outcome), the model that included the total number of 30 SHCs as a measure of multimorbidity was superior to the presence or absence of pressure ulcers, neurological deterioration, urinary tract infections, autonomic dysreflexia, respiratory infections, and deep vein thrombosis used as separate covariates (AIC 2011 vs AIC 2024). See **Appendix B** for more details on how the number of SHCs can discriminate among the 3 HCU groups and injury characteristics. When compared against group 3 (received needed care and not rehospitalized), being male (odds ratio [OR], 0.58; 95% CI, 0.42-0.79) was associated with receiving appropriate care in the community, whereas more SHCs (OR, 1.22; 95% CI, 1.17-1.27) and longer time since injury (OR, 1.01; 95% CI, 1.00-1.01) were significantly associated with not receiving needed care in the community (group 1). Living in one's own home (OR, 0.70; 95% CI, 0.49-0.99) and having an incomplete injury (OR, 0.68; 0.48-0.96) protected against being in group 2, while increasing age (OR, 1.02; 95% CI, 1.01-1.03), higher number of SHCs (OR, 1.11; 95% CI, 1.06-1.15), and longer time since injury (OR, 1.01; 95% CI, 1.00-1.01) were significantly associated with being in group 2 (receiving needed care but rehospitalized). For additional details, see **Table 3**.

Table 1. Description of the study population (N = 1,137)

Variable	Value
Mean ± *SD* age at injury, years	48.3 ± 13.3
Mean ± *SD* time since injury, years	18.5 ± 13.1
Gender, male	806 (70.9)
Mechanism of injury	
Transport	604 (53.1)
Fall	237 (20.8)
Sports	175 (15.4)
Assault	26 (2.3)
Other causes	95 (8.4)
Ethnicity	
Majority (White)	1,042 (92.0)
Minorities	91 (8.0)
Region of residence	
British Columbia	227 (20.0)
Prairies (Saskatchewan, Manitoba, and Alberta)	274 (24.1)
Ontario	245 (21.5)
Quebec	275 (24.2)
Atlantic Provinces (Nova Scotia, Newfoundland, New Brunswick, PEI)	116 (10.2)
Education level	
Less than high school	157 (13.9)
High school	268 (23.7)
Postsecondary education	385 (34.0)
University	322 (28.4)
Current living arrangements	
Single individual living with others	72 (6.3)
Single individual living alone	306 (26.9)
Living with spouse/partner	450 (39.6)
Parent living with spouse or partner and children	118 (10.4)
Single parent living with children	67 (5.9)
Child living with two parents with or without siblings	93 (8.4)
Other	23 (2.0)
Undeclared	6 (0.5)
Current living setting(s)	
Own home	793 (69.7)
Rental housing	233 (20.5)
Assisted-living	24 (2.1)
Hospital/long-term care facility	17 (1.5)
Others	66 (5.8)
Missing	4 (0.4)
Current household annual income, "prefer not to answer" excluded	
<$30,000	282 (30.3)
$30,000-$59,999	258 (27.7)
$60,000 and over	390 (41.9)
Self-reported current neurological classification	
Tetraplegia A or B	229 (20.1)
Paraplegia A or B	361 (31.8)
Tetraplegia C or D	301 (26.5)
Paraplegia C or D	184 (16.2)
Missing	62 (5.5)

Note: Values given as n (%), unless otherwise indicated. Income is given in Canadian dollars.

Table 2. Description of health care utilization in the past 12 months (N = 1,137)

Variable	Value
Rehospitalized, yes	297 (26.1)
Mean ± *SD* number of nights spent in the hospital (n = 297)	23.5 ± 46.7
Had a contact with an HCP, yes	1,017 (89.4)
Mean ± *SD* number of HCPs seen	3.5 ± 2.7
Mean ± *SD* frequency of any HCP seen[a]	32.7 ± 62.0
Type of HCP seen[b,c]	
Primary Care Physicians	904 (79.5)
SCI Specialized Physicians	565 (49.7)
Allied Health Professionals	655 (57.6)
Health Care Team	579 (50.9)
Needed care, but did not receive it	
Yes	292 (25.7)
No	845 (74.3)
Mean ± *SD* number of times needed care could not be received (n = 292)	9.82 ± 35.69
Type of care needed, but not received[b] (n = 292)	
Treatment of a physical health problem	243 (83.2)
Treatment of an emotional problem	44 (15.1)
Treatment of a mental health problem	25 (8.6)
Regular check-up	41 (3.6)
Care of an injury	44 (15.1)
Other	48 (16.4)
Reason for not receiving care[d] (n = 292)	
Access/availability of care	220 (19.3)
Personal reasons	120 (10.6)

Note: Values given as n (%), unless otherwise indicated.

[a]Ten participants were removed because they were considered to be outliers.

[b]The percentages may not equal 100%, because this item on the questionnaire allowed selection of more than 1 response.

[c]Grouping was as follows: Primary Care Physicians (General Practitioners, Family Doctors), SCI Specialized Physicians (Physiatrist, Respirologist, Spine Surgeon, Urologist), Allied Health Professionals (Occupational Therapist, Orthotist, Psychiatrist, Physiotherapist, Recreational Therapist, Respiratory Therapist, Speech-Language Therapist, Wound Care Nurse), Health Care Team (Case Manager, Drug and Alcohol Counsellor, Nurse, SCI Peer Support Person, Sexual Health Clinician, Social Worker, Vocational Counsellor).

[d]Grouping was as follows: Access/availability of care (not available in my area, not available at the time, waiting time too long, didn't know where to go, transportation problems, language problems, cost), personal reasons (felt it would be inadequate, too busy, didn't get around to do it/didn't bother, personal or family responsibilities, dislike doctor/afraid, decided not to seek care).

Effect of multimorbidity and HCU on patient outcomes

Multimorbidity and HCU were shown to have a significant effect on the participants' physical and mental health status as measured by the SF-12 PCS and MCS, respectively. Participants in group 1 had a lower PCS and MCS compared to group 3 (PCS 30.15 ± 8.35 vs 35.21 ± 8.50; MCS 46.19 ± 12.56 vs 54.14 ± 10.07). Older age (P < .001), male gender (P = .02), living in less populated cities (P = .001), being single (P = .03), in HCU group 1 (P < .001) or 2 (P = .04), and having more SHCs (P < .001) were significant risk factors for a lower PCS (worse physical health). Being single (P < .001), in HCU group 1 (P < .001) or 2 (P = .04), and having more SHCs (P < .001) were significant risk factors for having a lower MCS (P = .001) (worse mental health). See **Table 4** for more details.

In the final analysis that examined the factors associated with higher ratings of QoL, multimorbidity was not a significant covariate when HCU and health status (PCS and MCS) were included with LiSAT-11 first question (P = .79) or the single-item QoL measure (P = .48) as the dependent variable. Having an education of high school or greater (OR, 1.79; 95% CI, 1.33-2.41), a higher PCS (OR, 1.08; 95% CI, 1.06-1.10) and MCS (OR, 1.11; 95% CI, 1.09-1.12), and being married (OR, 1.73; 95% CI, 1.30-2.29) were significantly associated with being classified as satisfied using the LiSAT-11 first question. Being male (OR, 1.79; 95% CI, 1.23-2.61), having a higher PCS (OR, 1.14; 95% CI, 1.12-1.17) and MCS (OR, 1.14; 95% CI, 1.12-1.16), and being married (OR, 1.91; 95% CI, 1.36-2.67) were significantly associated with being classified as good using the single-item QoL measure (see **Table 5**).

Discussion

The need for comprehensive health care for persons with SCI living in the community as well as the need for more research to determine the impact of HCU on patient outcomes have been identified as priorities for the field. Results from this research build on existing evidence published to date using Andersen's model as a conceptual framework and start to address these

Table 3. Multinomial logistic regression analysis examining the association of demographic, injury, and multimorbidity factors on health care utilization

	Did not receive needed care and/or rehospitalized, (group 1)				Received needed care, rehospitalized (group 2)			
Variable	β	***P***	**OR**	**95% CI**	β	***P***	**OR**	**95% CI**
Live in own home	-0.25	.14	0.78	0.56-1.08	**-0.36**	**.04***	**0.70**	**0.49-0.99**
Incomplete SCI	-0.13	.43	0.88	0.65-1.20	**-0.39**	**.03***	**0.68**	**0.48-0.96**
Male gender	**-0.55**	**.001*****	**0.58**	**0.42-0.79**	0.03	.90	1.03	0.70-1.50
Age	0.01	.43	1.01	0.99-1.01	**0.02**	**.005****	**1.02**	**1.01-1.03**
Multimorbidity	**0.20**	**.001*****	**1.22**	**1.17-1.27**	**0.10**	**.001*****	**1.11**	**1.06-1.15**
Days since injury	**0.01**	**.003*****	**1.01**	**1.00-1.01**	**0.01**	**.002*****	**1.01**	**1.00-1.01**

Note: Two groups were compared with group 3 (received needed care and not rehospitalized), which was the reference group. Boldface indicates significant results. β = regression coefficient; OR = odds ratio.

**P*< .05. ***P*< .01. ****P*< .005.

Table 4. Multiple linear regression examining the association of demographic, injury, multimorbidity, and health care utilization on health status

	PCS			MCS		
Variable	β	***P***	**95% CI**	β	***P***	**95% CI**
Age	**-0.08**	**<.001*****	**-0.12 to -0.05**	0.03	.15	-0.01 to 0.08
Male gender	**-1.23**	**.02***	**-2.23 to -0.23**	-	-	-
Incomplete SCI	-	-	-	-1.19	.06	-2.45 to 0.07
Area of residence[a]	-	-	-	-	-	-
Large cities	**1.97**	**.004*****	**0.62 to 3.33**	-	-	-
Pop. >100,000	**2.11**	**.001*****	**0.92 to 3.31**	-	-	-
Pop. 10,000-100,000	-0.34	.64	-1.78 to 1.10	-	-	-
Not married	**-1.04**	**.03***	**-1.96 to -0.13**	**-2.09**	**.001*****	**-3.33 to -0.85**
HCU group 1[b]	**-3.12**	**<.001*****	**-4.25 to -2.00**	**-5.75**	**<.001*****	**-7.27 to -4.23**
HCU group 2[b]	**-1.33**	**.04***	**-2.58 to -0.08**	**-1.73**	**.04***	**-3.43 to -0.03**
Multimorbidity	**-0.77**	**<.001*****	**-0.88 to -0.66**	**-0.69**	**<.001*****	**-0.84 to -0.54**

Note: Boldface indicates significant results. β = regression coefficient; HCU = health care utilization; MCS = Short Form-12 Mental Component Score; PCS = Short Form-12 Physical Component Score; Pop. = population.

[a]Compared against residing in an area with population <10,000.

[b]Compared against group 3, received needed care and not rehospitalized; group 1, did not receive needed care and/or rehospitalized; group 2, received needed care but rehospitalized.

**P*< .05. ***P*< .01. ****P* < .005.

gaps. Multimorbidity was significantly associated with inappropriate HCU (group 1, did not receive needed care and/or rehospitalized) and together these factors were associated with lower health status. Furthermore, health status was significantly associated with participants' rating of their QoL, suggesting that SHCs and HCU have an indirect effect on this important outcome.

The identification of a person's needs and whether these are being met was a focus of the SCICS. Heinemann and colleagues[15] previously described the complex relationships between unmet needs and service. In our study, there was a paradoxical relationship between HCU and reported needs. Whereas Heinemann and colleagues reported that participants with

Table 5. Logistic regression analysis to examine the association of demographic, injury, multimorbidity, health care utilization, and health status on quality of life

	LiSAT-11 question 1				Quality of life question			
Variable	β	***P***	**OR**	**95% CI**	β	***P***	**OR**	**95% CI**
Ethnicity, White					-0.59	.05	0.55	0.30-1.01
Gender, male	0.30	.06	1.35	0.99-1.85	**0.58**	**.003*** **	**1.79**	**1.23-2.61**
Education high school or more	**0.581**	**<.001*** **	**1.79**	**1.33-2.41**	-	-	-	-
Married	**0.547**	**<.001*** **	**1.73**	**1.30-2.29**	**0.65**	**<.001*** **	**1.91**	**1.36-2.67**
PCS	**0.075**	**<.001*** **	**1.08**	**1.06-1.10**	**0.13**	**<.001*** **	**1.14**	**1.12-1.17**
MCS	**0.101**	**<.001*** **	**1.11**	**1.09-1.12**	**0.13**	**<.001*** **	**1.14**	**1.12-1.16**

Note: Boldface indicates significant results. β = regression coefficient; LiSAT-11 = Life Satisfaction Questionnaire; MCS = Short Form-12 Mental Component Score; OR = odds ratio; PCS = Short Form-12 Physical Component Score.

*$P < .05$. **$P < .01$. ***$P < .005$.

traumatic brain injury with greater unmet needs had less access to health services,[15] participants in our study with traumatic SCI with high rates of rehospitalization and unmet health care needs also had the highest number of health care visits, which suggests there are individuals who are not getting their health effectively managed in the community. This seemingly contradictory finding of the 2 studies might be due to the difference in the health care systems. Heinemann's study took place in the United States, which has private health care, whereas our study took place in Canada, which has universal health care. The overall rehospitalization rate in our study was 26.1% (n = 297), which is similar to other studies in Canada[3] but is slightly lower compared to the United States where it has been reported to be as high as 70% within a 1-year period.[16] The frequency of visiting HCPs was also high. On average, participants saw 3.5 different HCPs and the mean frequency of seeking the services from one of these HCPs was 32.7 times in a 12-month period. The most frequent HCP seen was a general practitioner (79.5%; n = 904), and 1.0% to 38.6% (n = 7-439) visited a specialist in the past year. HCU reported in this study was lower compared to a recent study by Stillman and colleagues who reported almost all subjects seeing a general practitioner and 85% visiting a specialist,[17] but it was still quite high. Despite these high levels of HCU, it was surprising to find such a high rate of unmet care needs. Reasons for not being able to access these services were related more to the availability of service ("waiting time too long") than personal reasons ("decided not to seek care"), reinforcing what DeJong stated about the deficiencies of the health care system for people with SCI over 25 years ago.[1]

To better understand why some individuals with SCI are not able to effectively navigate through the health care system, 3 groups were created based on individuals' perceptions and use of the health care system, ranging from group 3 representing appropriate care (received care and not rehospitalized) to group 1 comprising those with inappropriate care (did not receive needed care and/or rehospitalized). It was interesting to note a significant association between the number of SHCs and the HCU group assignments. In group 1, in which participants had the worst outcomes, the number of SHCs reported on average was 15.14 (*SD* 3.86), whereas this decreased to 12.00 (*SD* 4.16) in group 3. When comparing the total number of SHCs to the presence or absence of 6 specific SHCs typically associated with an emergency hospital readmission (eg, urinary tract infection), an examination of the presence of multiple SHCs simultaneously predicted the participant's HCU better than an examination of each major SHC individually. Increasingly there is a focus on addressing the health care needs of individuals with multiple chronic conditions, which is defined as having 2 or more concurrent chronic conditions.[18,19] Given the number of SHCs experienced by individuals living with SCI and the uphill battle to manage them in the current health care system,[11] it is evident that innovative

and tailored approaches are needed to overcome system fragmentation and disparities in accessing services; some solutions have been proposed.[20]

Furthermore, the model developed in this study identified characteristics associated with the assignment of the HCU groups. Important factors include the number of SHCs, gender, time since injury, living situation, type of SCI and age, many of which have already been identified in other studies.[21] These factors are easily measured during routine clinical visits and could form the basis of a screening tool to identify who requires specialized health care services to prevent a potential inappropriate HCU such as hospital re-admission in the future. As mentioned previously, most individuals visit their general practitioner yearly but only 15.8% (n = 103) visit a physiatrist and 7.5% (n = 49) have SCI peer support, which may not be enough based on results of this study. Individuals with the risk factors identified as being associated with HCU groups 1 and 2 should be flagged and treated by an interdisciplinary team to deal with their complex health needs; a yearly check-up with such team and the introduction of self-management programs may prevent long-term health problems and visits to an emergency department for preventable and low acuity conditions.[4] Going upstream to the acute and rehabilitation settings and identifying participants at risk of future inappropriate HCU and providing targeted education may prevent downstream problems, an approach that was suggested by Krause and Saunders.[22]

In addition to describing HCU, this study also linked utilization to outcomes. To date, few studies have examined the impact of multimorbidity and HCU in SCI.[11] Some initial research by Suzuki and colleagues[23] demonstrated that individuals with SCI who have more social and emotional support, superior health coverage, and greater access to services in their community report fewer SHCs. It was therefore not surprising that our study also found both inappropriate HCU and multimorbidity to be negatively associated with physical and mental health status. When the outcome was QoL, the impact of multiple SHCs and HCU was replaced by the SF-12 PCS and MCS. This suggested a hierarchical relationship and the need to consider more advanced statistical techniques such as structural equation modeling to construct latent variables and examine these complex associations in more detail. These techniques have been used in other studies.[23,24] This research is important; results from this study suggest that addressing SHCs could impact overall QoL for persons living with SCI.

When considering the results from this study, it is important to note its limitations. Results are based on self-reported data from the participants, so there may be issues with recall bias or inaccuracy in reporting conditions, such as autonomic dysreflexia, that have specific clinical features. In addition, the sample may not be representative of the SCI population in Canada, as 71% of all respondents were male, 92% reported their racial status or ethnicity as White, and the recruitment process did not use a randomization process or ensured geographic representation. Data from this study have reported hospitalizations, but no details were obtained on the reasons, which should be included in future studies.[25] Finally, this sample only included persons who sustained a traumatic SCI, and future studies on persons with nontraumatic SCI are required. However, even with these limitations, the SCICS is the largest Canadian SCI survey, and it was able to identify people with SCI who are at risk of falling through the cracks in the Canadian health care system. These results should inform new approaches to SCI community care.

Results from this study demonstrate that multimorbidity and HCU are interrelated and negatively impact health outcomes. Future work will develop a screening tool to identify persons at risk of inappropriate HCU (eg, rehospitalization) due to problems such as multimorbidity to help optimize health status, reduce health care costs, and ultimately improve QoL for persons with SCI.

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APPENDIX A

Table A1. Cross-tab comparison of LiSAT-11 question 1 and quality of life question responses

	Quality of life question, % (*n*)		
	Poor	**Good**	**Total, % (*n*)**
LiSAT-11 question 1			
Not satisfied, % (n)	57.1 (323)	42.9 (243)	100.0 (566)
Satisfied, % (n)	8.1 (46)	91.9 (525)	100.0 (571)
Total, % (n)	32.5 (369)	67.5 (768)	100.0 (1137)

Note: LiSAT = Life Satisfaction-11 Questionnaire.

Table A2. List of all the variables considered in the analysis

Domains	**Variables**
Modifiers	
External environment	Region of residence Western Canada (British Columbia, Alberta) Prairies (Saskatchewan, Manitoba) Eastern Canada (Ontario, Quebec) Maritime Provinces (Nova Scotia, New Brunswick, PEI, Newfoundland) Urban versus rural, population <10,000 10,000-100,000 100,000+ Large metropolitan cities No record
Population characteristics	Mean age at injury Mean years post injury Gender Ethnicity White Other Prefer not to answer Mechanism of injury Transport Fall Sports Assault Other causes Self-reported current neurological classification Tetraplegia A or B Paraplegia A or B Tetraplegia C or D Paraplegia C or D No record

(Continued)

Table A2. Continued

Domains	Variables
Modifiers	
	Highest education completed at the time of injury Less than high school High school College/university Graduate studies Others Missing Current living setting(s) Own home Rental housing Assisted living Hospital/long-term care facility Others Missing Current living arrangements Alone With partner/spouse With family With paid attendant With a non-family member, nonpaid Prefer not to answer Current marital status Not married (single, divorced, separated, widowed) Married (married, living common law) No record Current employment status Employed (by an employer, self-employee) Non-paid work (volunteer, homemaker) Student (student, apprentice, vocational rehab program) Not working (looking for paid work, retired) Others Current annual household income, Canadian dollars 0-39,999 40,000-59,999 60,000-99,999 100,000+ No record Subjective needs Attendant care needs Income needs Equipment needs SCI services needs General health needs Short distance transport needs Emotional counselling needs Case management needs SCI peer support needs Healthy living, recreational and leisure programs needs
Health behavior	Maintaining physical health (questions 1, 2) Maintaining mental well-being (questions 1, 2) Accessing services in the community (questions 1, 2) Accessing services in the community (questions 1, 2) Accessing services in the community (questions 1, 2)
Multimorbidity (categorization #1)	Presence of any of the following: urinary tract infections, pressure ulcers, autonomic dysreflexia, deep vein thrombosis, respiratory infections, neurological deterioration

(continued)

Table A2. Continued

Domains	Variables
Modifiers	
Multimorbidity (categorization #2)	Total number of comorbidities and complications (maximum of 30)
Health care utilization	Did not receive needed care and/or rehospitalized (group 1) Received needed care but rehospitalized (group 2) Received needed care and not rehospitalized (group 3)
Patient outcomes	Health status Short Form-12 Physical Component Score Short Form-12 Mental Component Score Quality of life Quality of life single-item measure Life Satisfaction-11 first question

APPENDIX B

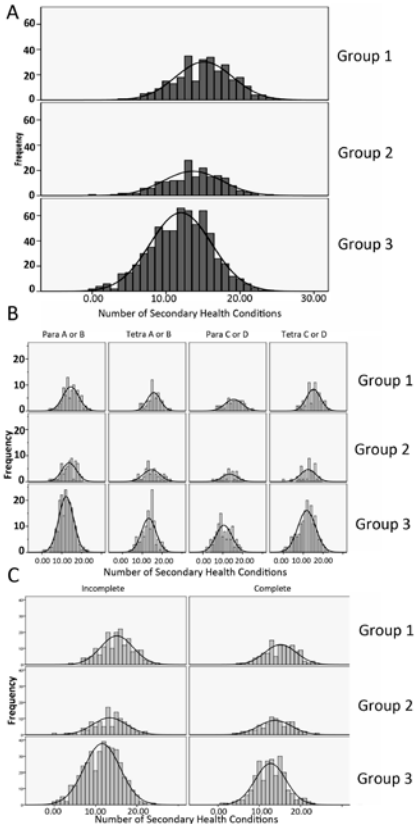

Figure B1. Distribution secondary health conditions (multimorbidity) among the 3 health care utilization groups and their severity of injury: group 1, did not receive needed care and/or rehospitalized; group 2, received needed care but rehospitalized; group 3, received needed care and not rehospitalized. (Panel A) Distribution of the number of secondary health conditions among the 3 health care utilization groups. (Panel B) Distribution of the number of secondary health conditions among the 3 health care utilization groups and injury types. (Panel C) Distribution of the number of secondary health conditions among the 3 health care utilization groups and completeness of injury.